A Work Project, presented as part of the requirements for the Award of a Master's degree in Management from the Nova School of Business and Economics.

Carbon Credit Card Services and the Impact Potential on CO2 Emissions in the EU – Conceptualization of a CO2 Reduction Impact Model

Simon Lindström

Work project carried out under the supervision of:

Professor José Miguel dos Santos Hortas Pita

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Abstract

Section 3 presents a conceptual overview of the CO2 Reduction Impact Model. The model aims to investigate the reduction potential of EU carbon emissions over the next ten years by the adoption of Carbon Credit Card Services. Three scenarios have been developed to determine the impact potential based on different levels of improved sustainable behavior by users. The three scenarios are then impacted by three main factors: emission development, user development and behavior & adaption. Additionally, personas with individual behaviors are generated to represent the EU population. By improved sustainable behavior among the personas, the impact of Carbon Credit Card Services increases.

Keywords

Conceptualization

CO2

Reduction

Impact

Model

Factors

Behavior

Change

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Work Project team contact information

Student Central – Planning and Academic Progress Team

Phone: (+351) 213 801 691

Email: workprojects@novasbe.pt

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Section 3: Conceptualization of a CO2 Reduction Impact Model

Sections	Research questions	Methodologies
Key Question	**What are the main steps and key factors of the CO2 Reduction Impact Model?**	
3.1 Conceptual model explanation	**How can the model be conceptually explained?** ➢ What is the context of the model? ➢ What are eight key steps in the model? ➢ What are the three scenarios?	> SCQA framework > Conceptual model design
3.2 10-year emission development	**What levels of carbon emissions are being used?** ➢ How are the carbon emissions forecasted over the next ten years? ➢ General approach for the measurement of carbon emissions on consumer-side ➢ Analysis of addressable emissions and within the four categories	> External research > Data analysis > Forecasting
3.3 User Development	**How is the addressable population and users determined?** ➢ What are the three criteria determining the addressable population? ➢ How is the number of users calculated over the next ten years? ➢ What are the five personas?	> External research > Criteria analysis
3.4 Behavior & Adaption	**How is user behavior represented?** ➢ What are the different user behaviors considered? ➢ What are the characteristics of each behavior? ➢ How is behavioral change displayed?	> Modeling persona behavior

Conceptual model overview

A SCQA framework demonstrates the basic context while also determining the scope of the model

Basic context and scope of the model

Situation

Several companies have evolved in the market for **Carbon Credit Card Services** during the last few years. The market is still in an **early development stage** and **their impact is yet to be determined**

Complication

For the **CCCS market to be successful** there is a **need** for providers to **prove the impact** of their services while disproving that they are not simply riding the green wave

Question

What is the **potential contribution** of **Carbon Credit Card Services** in the battle against carbon emissions in the EU?

Answer

The analysis is a **thought experiment** that evaluates the impact based on 3 major factors:

- ***Emission development***
- ***User development***
- ***Behavior & adaption***

Scope

- **Proof of concept**
- Member countries of the **EU (including UK)**
- Time point analysis of **2021, 2025 & 2030**
- **Forecast** of CO2 emissions and CCCS users
- **Scenarios** based on different assumptions to **illustrate potential impact**

Out of Scope

- Country specific data is **not given**
- Total accuracy is **not possible** due to lack of current data availability
- Forecasts are mainly based on historic data, **no likelihood assessment** can be given
- Actual possible reach of players is **not considered**

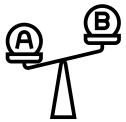
The key elements of the CO2 reduction impact model together serve as the foundation for the thought experiment

A model overview

Scenario-based

3 scenarios to determine the impact of CCCS

Comparison



A **comparison between scenarios** is performed to measure the potential impact of CCCS

Personas

5 personas represent the EU population, and their behavior is what drives change throughout the scenarios

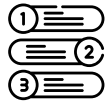
Time frame

The model investigates **a 10-year time frame** with 3 milestones:
2021 – 2025 – 2030

8 steps

From start to finish the result of each scenario is achieved in an **8-step calculation process**

3 factors



3 factors influence the 8-step process:
- 10-year emission development
- User Development
- Behavior & adaption

A conceptual understanding of the model is presented to visually explain the 8 key steps of the CO2 reduction impact model

The CO2 reduction impact model from start to finish

1	Total Users	From total EU population the addressable population is generated. **Addressable population x penetration ratio = total users**
2	Persona Allocation	The **users are allocated towards 5 personas** ranging from the most to the least sustainable persona
3	Carbon Factor	Each of the **four emission categories** has **two carbon factors** assigned to them. A carbon factor is the **emissions per € spent** and each category has a high and a low carbon factor
4	Expenses Allocation	Each **persona spends** a certain amount in each of **four categories**. The expenses are divided between **high** and **low emissions** products. Cash purchases are not included in the model, only card purchases are accounted for
5	Individual Emissions	Based on the carbon factors and expenses across categories a **yearly carbon footprint** is generated for **each persona**
6	Total Emissions	Adding up the emissions of all users in each persona gives **the total yearly emissions of CCCS users**
7	Offsetting	Each **persona offsets** a **certain percentage** of their footprint. Accounted for as a **reduction of their total yearly emissions**
8	Output	The **reduction of EU emissions** by the **adoption of CCCS** over a **10-year time frame**

Source: CO2 Reduction Impact Model (2021).

The 3 scenarios assume different consumer behavior development presented as a shift in the allocation among personas

General assumptions and the three scenarios

General Assumptions

- Difference in scenarios are driven by **changes in improved sustainable behavior** across personas
- Improved sustainable behavior depends on the **willingness to change behavior** over the next 10 years according to survey respondents
- By **changing behavior**, a user can **leave its persona** and **adopt** the **behavior of another persona**
- A user can only become a **new persona once in ten years** and it is **only** possible to adopt the behavior of the **nearest above persona**
- The change among individual users in the five personas is the **ONLY difference between scenarios**

Scenario 1 – Zero Change

- Assumes **no behavioral change** among personas
- Due to no improved behavior the persona allocation remains the same over the 10-year period

Scenario 2 – Slow Change

- Assumes a **slow change** in improved sustainable behavior among personas
- Due to a slow improvement in behavior, we see a **slight increase** in more **sustainable** personas and a decrease in less sustainable personas

Scenario 3 – Rapid Change

- Assumes a **rapid change** in improved sustainable behavior among personas
- Due to a rapid improvement in behavior, we see a **large increase** in more **sustainable** personas and a decrease in less sustainable personas

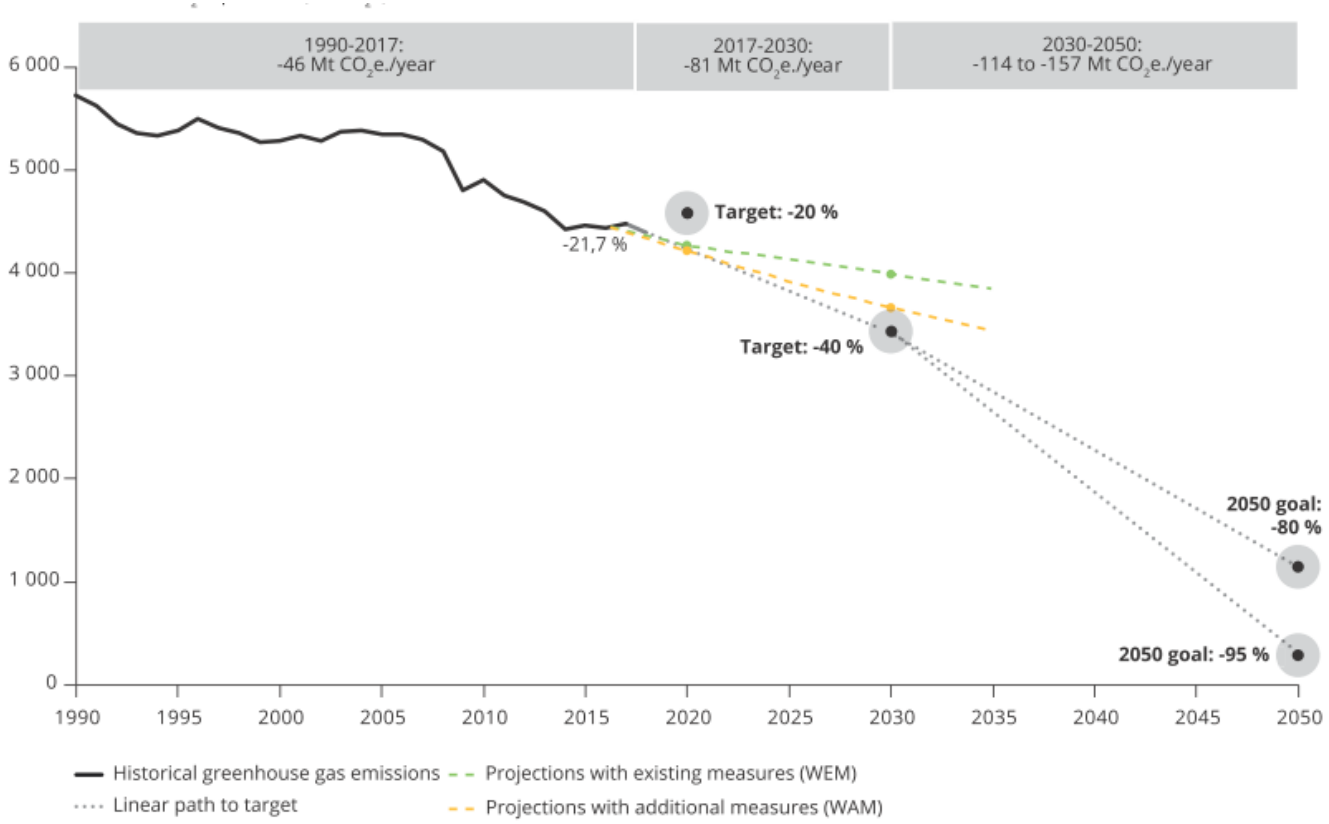
Source: CO2 Reduction Impact Model (2021).

Model factors

- **Factor 1:** 10-years emission development
- **Factor 2:** User development
- **Factor 3:** Behavior & adaption

Latest projections assume a reduction of the EU-28 carbon emissions of 30% below the 1990 levels to be reached by 2030

Factor 1: CO2e and CO2 projections



Key Insights

Trends

- **2017**: total EU GHG emissions at 4.483 megatons of carbon dioxide equivalent
  → **21.7% lower** than **1990 levels**
- **2018**: emissions **23.2% below** the 1990 levels

Targets

- **2020** target of **20% reduction** can be expected **to be met**
- **2030** target of **40% reduction** is **not** going to be **reached** according to latest projections

Projections

- Latest projections assume a reduction of **30% by 2030**

2030 CO2 equivalents* = 4.008 megatons

2030 CO2 = 3.295 megatons

*The following analysis is focused only on CO2, without other greenhouse gases; based on the predicted reduction of 30% lower than 1990, the total CO2 emissions in 2030 are expected to be 3.295 megatons

Source: 10-year Emission Development (2021) and European Environment Agency (2019a).

The underlying analysis of the emission development in the model is based on the consumption perspective of carbon emission measurement

Factor 1: The EU reports carbon emissions in two different ways

Production Perspective

Direct emissions by households *(from burning fossil fuels, e.g., heating dwellings, fueling private vehicles)*

+

Emissions by EU production activities *(Emissions calculated on specific industry level)*

↓

Most accurate approach (domestic technology assumption)

Difficult to calculate on **individual level**

Consumption Perspective

Direct emissions by households *(from burning fossil fuels, e.g., heating dwellings, fueling private vehicles)*

+

Emissions due to domestic demand for products *(including emissions from intermediate products and avoided emissions due to imports)*

↓

Known as the **carbon footprint approach**

Possible to calculate **on individual level.** Used by CCCS providers

Carbon footprint approach

- The point of reference is the final product, hence the consumption perspective of CO2 emissions
- The carbon footprint estimates are based on single-region environmentally-extended input-output modeling
- The consumption perspective takes into consideration the entire supply chain of a product and therefore loses some accuracy
- Emission estimations are based on the Air Emissions Account (AEA), which record emissions of industries/activities of private households across:

64 categories

Source: 10-year Emission Development (2021) and Eurostat (2020b).

The consumption-based emissions are distinguished between transportation, housing, nutrition products/services and non-addressable emissions

Factor 1: Addressable emissions forecast through the four categories

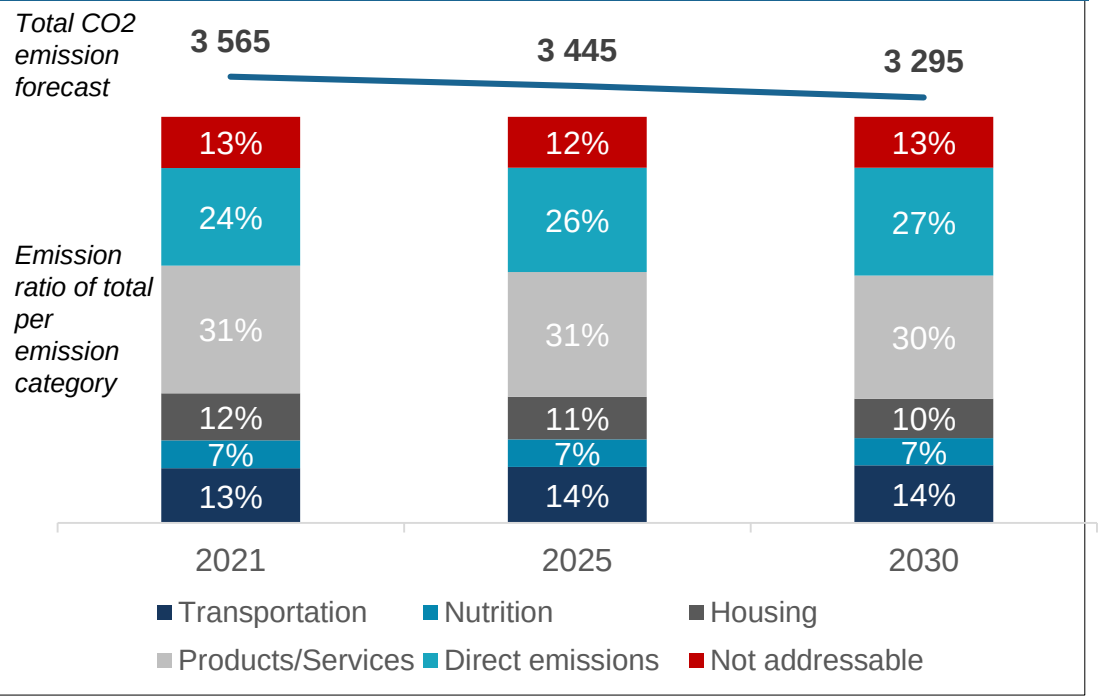
64 AEA → **57 categories** → **4 emission categories**

emissions categories **could be allocated towards the 4 model/CCCS categories**

Transportation **Housing**

Nutrition **Products/Services**

Addressable and non-addressable emissions (in megatons)



Key Insights

High coverage & high addressable emissions

- Only **7** out of 64 categories **cannot** be allocated to a model category
- According to the analysis, **12-13%** of the emissions are therefore **not covered** by these **57 categories**

Not addressable emissions mainly depicted by construction

- The **13%** of non-addressable emissions are **mainly** depicted by **construction emissions**

Addressable emissions forecast (in megatons)

2021	2025	2025
3,102	3,032	2,867

The products with the highest emissions are: 1) Electricity, Gas, Steam and air condition (housing), 2) Construction and construction works (not addressable), 3) Food, beverages and tobacco (nutrition). Direct emissions are also represented in the model, mainly in transportation (fueling private vehicles) and housing (heating dwellings).

Source: 10-year Emission Development (2021), Eurostat (2020b), Eurostat (2020c) and European Environment Agency (2019a).

The addressable population is determined by the criteria population, demographic and living standards

Factor 2: Three criteria determine the addressable population

Criteria	Characteristics	
Population	Who	Residents of the European Union (Inc. the United Kingdom)
	Why	Initial layer to determine the addressable population
Demographic	Age	$15 \leq X \geq 64$
	Gender	Male, Female, Other
	Why	The active working range with capabilities to use not only a credit card but a tech-based credit card
Living standards	Living standards	Not at risk of poverty according to EU standards
	Why	Sustainable consumption is a luxury not available to those at risk of poverty

The user development is determined by a relatively stable addressable population which is multiplied by the penetration rate for each year

Factor 2: Addressable population generated through set criteria as a foundation for the number of users

2021	2025	2030
Population **516** million people reside in the European Union and UK	**Population** **518** million people reside in the European Union and UK	**Population** **519** million people reside in the European Union and UK
Demographic **183** million people do not meet the set criteria	**Demographic** **192** million people do not meet the set criteria	**Demographic** **195** million people do not meet the set criteria
Living Standards **57** million people do not meet the set criteria	**Living Standards** **55** million people do not meet the set criteria	**Living Standards** **55** million people do not meet the set criteria
Addressable Population **276** Million	**Addressable Population** **271** Million	**Addressable Population** **269** Million

User Development

Addressable Population ✖ **Penetration Rate** = **Users**

Source: Eurostat (2020d), Eurostat (2020e), Eurostat (2020f) Eurostat (2020g), Worldometer (2020) and ONS (2019).

A survey was executed to understand consumer behavior and to allocate the respondents to personas based on the level of sustainability

Factor 2: Survey sections leading to the five personas

Survey Sections	Aim of survey sections
Awareness	Understanding **awareness of climate change** and **carbon footprint**
Behavior	Understanding the **environmental approach** of respondents
Expenses	Understanding **purchase behavior**
Willingness to use	Understanding the willingness to **use CCCS** and its services
Willingness to change behavior	Understanding the willingness to **change** to a more sustainable behavior

Ranging from the most sustainable to the least sustainable

Most sustainable

Environmental Activist

Green Thinker

Occasional Actor

Indifferent Bystander

Counterproductive Opponent

Least sustainable

Source: Survey Evaluation Carbon Credit Cards (2021).

Three different persona behaviors are seen in the model and these behaviors are what ultimately drives change throughout the scenarios

Factor 3: Overview of the three different behaviours

	Cash vs card	Offsetting	Expenses allocation
What	**How much** of user expenses are paid by credit card	The level of footprint offsetting made by **users yearly**	The user's **allocation of expenses** towards high emission products and low emission products
Why	Determines **how much** of a user's footprint can be calculated	Offsetting is in the model accounted for as a **reduction in total emissions**	The carbon **footprint** of users **depends** on the allocation of expenses
How	CCCS providers track purchases digitally and can therefore **only register card payments**	Each persona offsets **a certain percentage** of their total carbon footprint	A more sustainable persona allocates a **greater part of their expenses** towards low emissions products and therefore has a lower footprint

The addressable emissions in the model are further influenced by user´s transaction behaviors with regards to card vs. cash spending

Factor 3: Cash vs. Credit Card transactions

How can the CCCS providers register consumer purchases?

Non-measurable emissions

Cash Transactions

- Providers **cannot track** cash expenses
- Allocation towards the four categories **is not possible**
- Providers **cannot estimate** the carbon footprint of a cash purchase

→ Expenses and emissions **not included** in the model

Measurable emissions

Card Transactions

- ✓ Providers **can track** Card expenses
- ✓ Allocation towards the four categories **is mostly possible**
- ✓ Providers **can estimate** the carbon footprint of a card purchase

→ Expenses and emissions **included** in the model

Transaction Behavior

- Each persona has its own **transaction behavior**
- Transaction behavior = **Percentage** of total expenses paid **by credit card**

Example

- The Environmental Activist uses a credit card for **80%** of **total expenses**
- The Counterproductive Opponent uses a credit card for **73%** of **total expenses**

Source: Survey Evaluation Carbon Credit Cards (2021) and CO2 Reduction Impact Model (2021).

The model is further influenced by the user's tendency to offset carbon emissions which results in lower net emissions

Factor 3: Example of how the model processes offsetting

1

Current measurable individual emissions

5.6 t

Each personas has its own individual carbon footprint based on consumption behavior

2

Emission reduction through Offsetting

- 1.9 t

Each persona offsets a fixed percentage of their yearly footprint based on answers given by survey respondents

3

Resulting Net Emissions

= 3.7 t

Offsetting is accounted for as a **reduction of total emissions** and therefore decreases the net emissions

Source: Survey Evaluation Carbon Credit Cards (2021) and CO2 Reduction Impact Model (2021).

All products are classified as high or low emission products and each persona allocates a fixed portion of their expenses towards both two classes

Factor 3: The process of allocating expenses

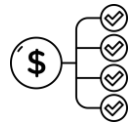
Classification

Purchases within categories are classified as **low emission** products or **high emission** products

High and Low emission products

Examples

High	Low
• Non-renewable energy	• Renewable energy
• Car	• Public transport
• Carnivore diet	• Vegetarian diet
• Imported	• Locally produced



Allocation

- The **expenses** of **each persona** within **each category** are then **allocated** towards **high and low emission** products.
- The more sustainable the persona the more expenses are allocated towards low emission products

Allocation example

Very sustainable

The **Environmental Activist allocates 90%** of all expenses across all categories towards **low emission products** and only 10% towards high emission products

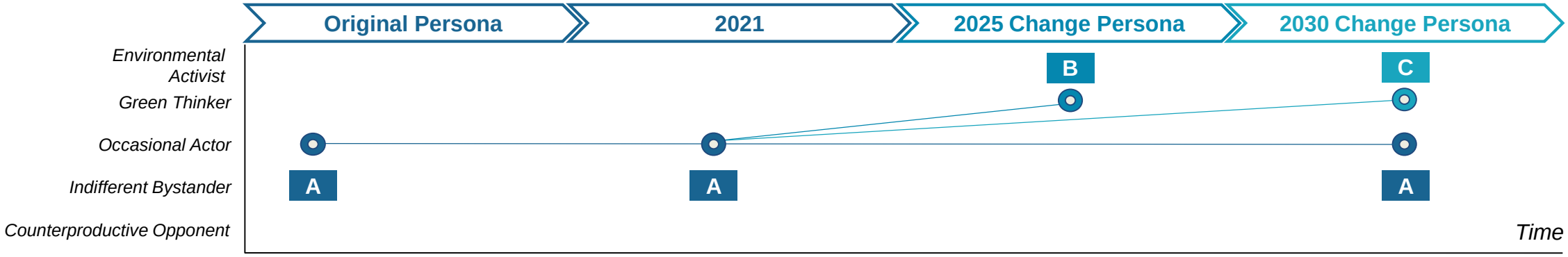
Less sustainable

An **Occasional Actor allocates 50%** of all expenses across all categories towards **low emission products** and 50% towards high emission products

Source: Survey Evaluation Carbon Credit Cards (2021) and CO2 Reduction Impact Model (2021).

Behavioral change by adopting the behavior of another persona enables an individual to climb up and become a more sustainable persona

The process of becoming a new persona*: Example of an Occasional Actor



How

- All respondents were asked questions **regarding if and when they would change** to a more sustainable lifestyle
- By **adopting ALL three behaviors** of an above persona a user in a lower persona can climb up and become a new persona
- It's only possible to **climb up one** persona in ten years

Resulting in

- **A** **Not willing** to change – **remain** in same persona
- **B** Willing to **change by 2025** – climb **up one** persona
- **C** Willing to **change by 2030** – Climb **up one** persona

- Users **willing to change by 2025** climb up one step to a more sustainable persona

- Users **willing to change by 2030** climb up one step to a more sustainable persona

Example Occasional Actor

- **A** An Occasional Actor **not willing** to change
- **B** An Occasional Actor **willing** to change by **2025** becomes a Green Thinker
- **C** An Occasional Actor **willing** to change by **2030** becomes a Green Thinker

*Example of how a users move between personas. Not an actual representation of a specific scenario.

Source: CO2 Reduction Impact Model (2021).

Key takeaways - Conceptualization of a CO2 Reduction Impact Model

Sections	Research questions
Key Question	**What are the main steps and key factors of the CO2 Reduction Impact Model?**
3.1 Conceptual model explanation	➢ **An 8-step process** explains the crucial steps of the model from start to finish ➢ **Key question:** What is the **potential contribution** of **Carbon Credit Card Services** in the battle against carbon emissions in the EU? ➢ 3 scenarios with the only difference being changing persona allocation due to the level of behavioral change
3.2 10-year emission development	➢ **Projected EU emissions** are forecasted to be **3,102** (2021) **3,032** (2025) **2,867** (2030) megatons CO2 per year ➢ The carbon footprint is **calculated** through the **consumer perspective method** ➢ **87%** of total EU emissions **can be addressed through four categories** (Transportation, Nutrition, Housing, Products/Services)
3.3 User Development	➢ **Criteria –** Eu resident between the ages of 15-64, not at risk of poverty ➢ **Addressable population – 276M** (2021) **271M** (2025) **269M** (2030). ➢ **The personas**: Environmental Activist, Green Thinker, Occasional Actor, Indifferent Bystander, Counterproductive Opponent
3.4 Behavior & Adaption	➢ **3 different behaviors:** Cash vs card, Offsetting and allocation of expenses ➢ A persona's carbon footprint depends on the **outcome of each behavior** ➢ **Change persona:** An individual within a persona can either not change and remain in the same persona or change and **climb up one step** to a more sustainable persona in either 2025 or 2030 **by adopting ALL** behaviors of the above persona

References

Reports and Webpages:

European Environment Agency (2019a). *Trends and projections in Europe 2019.* Retrieved on December 1st, 2020 from: https://www.eea.europa.eu//publications/trends-and-projections-in-europe-1
.

Eurostat (2020b). *Greenhouse gas emission statistics – carbon footprints*. Retrieved on October 18th, 2020 from: https://ec.europa.eu/eurostat/statistics-explained/index.php/Greenhouse_gas_emission_statistics_-_carbon_footprints#Carbon_dioxide_emissions_associated_with_EU_consumption.

Eurostat (2020c). *Emissions of greenhouse gases and air pollutants from final use of CPA08 products - input-output analysis, ESA 2010.* Retrieved on October 28th, 2020 from: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_io10&lang=en.

Eurostat (2020d). *Population structure and ageing.* Retrieved on October 15th, 2020 from: https://ec.europa.eu/eurostat/statistics-explained/index.php/Population_structure_and_ageing#The_share_of_elderly_people_continues_to_increase%20(2020).

Eurostat (2020e). *Population on 1st January by age, sex and type of projection.* Retrieved on October 14th, 2020 from: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=proj_19np&lang=en.

Eurostat (2020f). *At-risk-of-poverty rate by poverty threshold, age and sex.* Retrieved on October 15th, 2020 from: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_li02&lang=en.

Eurostat (2020g). *Population projections in the EU.* Retrieved on October 17th, 2020 from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=People_in_the_EU_-_population_projections&oldid=497115#Age_dependency_ratios.

Office for National Statistics (2019). *National population projections: 2018-based.* Retrieved on October 13th, 2020 from: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2018based.

Worldometer (2020). *U.K. population.* Retrieved on October 13th, 2020 from: https://www.worldometers.info/world-population/uk-population/#:~:text=the%20United%20Kingdom%202020%20population,(and%20dependencies)%20by%20population.

Reduction Impact Model and Survey:

Schweers, Sebastian., Lindström, Simon., Carrez, Nathalie, and Kreß, Teresa. *CO2 Reduction Impact Model,* V1 (January 04, 2021), distributed by Nova School of Business and Economics.

Schweers, Sebastian., Lindström, Simon., Carrez, Nathalie, and Kreß, Teresa. *10-year Emission Development,* V1 (January 04, 2021), distributed by Nova School of Business and Economics.

Schweers, Sebastian., Lindström, Simon., Carrez, Nathalie, and Kreß, Teresa. *Survey Evaluation Carbon Credit Cards,* V1 (January 04, 2021), distributed by Nova School of Business and Economics.